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ARTICLES ON SAND-CARRYING WIND, TEMPERATURE VARIATIONS, AND HYDROGRAPHY OF CERTAIN AREAS IN COMMUNIST CHINA

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ARTICLES ON SAND-CARRYING WIND, TEMPERATURE VARIATIONS, AND HYDROGRAPHY OF CERTAIN AREAS IN COMMUNIST CHINA

[These articles are from the Ti-li Hsueh-pao (Acta Geographica Sinica), No 1, February 1959, Peiping.]

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I. SAND-CARRYING WIND AND DRIFT SAND

Pages 38-39
(Russian abstract)

Keng K'uan-hung

Studies verify that sand-carrying wind in the deserts of Ai-ma-k'a Pan-i-ts'o-erh in the western part of Inner Mongolia and the district of Chan-i of the Ho-hoi corridor has a velocity of more than 5 m/sec at a height of 6 m.

With such a wind speed index and by the rules of vertical distribution of wind speed, we made an analysis of sand-carrying wind in these areas, using wind velocity data of the meteorological stations. It was discovered that in these areas there exist two large wind systems which lift sand. Their boundary is located to the west of River Edzin-gol, some 98-100 east longitude. East of this boundary a northwest wind prevails and west of this boundary, a northeast wind. As to the frequency and composite velocity of the sand-carrying wind, in the south it is infrequent and weak but in the north it is frequent and strong. This boundary runs along the Lunshou, Kheli, Ulun and Lunshan ridges. It is strongest in the spring and weakest in the summer and autumn.

Research shows that in these areas the distribution of drift sand depends on the winds which carry the sand and the aeolian sand deposits, for the most part, become barkhans. The formation and distribution of barkhans are determined by three main factors: the wind which lifts the sand, the source of the sand and the relief. It is necessary to pass through four stages to form a barkhan.

The wind which lifts the sand is the motive force in the shifting of barkhans. The direction and the distance of movement of dunes in various areas for each month of the year (not only in territorial distribution but also in the course of the year) correspond to the wind which lifts the sand. That is why the line located a short distance west of the River Edzin-gol is once more taken as the boundary. East of this boundary, the dunes move in a southeast direction and west of it, in a southwest direction. In these cases, all those in the south move rapidly while those in the north move slowly. They move most rapidly in the spring and most slowly in the summer.

As the result of the analysis of the routes of movement of the dunes, it was discovered that in these areas the method of transfer varied from place to place. For instance, we can differentiate three forms of movement: fast speed, medium speed and slow speed. The first takes a direct route while the latter two take meandering routes.

The distance of dune movements was calculated only from the speed of the wind which carries the sand and does not consider the effects of relief obstructions or the earth's surface. Consequently, the results obtained represent the optimimum distance which is greater than the actual. However, it is very close to actual conditions; therefore, the movement of dunes calculated from the wind which carries the sand is reliable and has practical value.

II. THE GENERAL CHARACTERISTICS OF TEMPERATURE DROP IN WINTER IN SOUTHERN CHINA

Pages 47-66 (excerpts)

Chiang Ai-liang
Institute of Geography
Chinese Academy of Sciences

Basic Conditions Pertaining to Temperature Variations in South China During the Winter

The climate of South China is basically mild (based on temperature data for China, the mean temperature of the four months from November to the following February for Nanning and Canton shows it is above 15°C, while the mean for the two coldest months of January and February shows it is above 13°C). However, it is during this winter period that a sharp drop in temperature takes place. Based on readings from Nanning and Canton, a chart is drawn to show the daily temperature changes during the winter, as seen in Figure 1.

Recordings for the graphs in Figure 1 are selected from readings taken during the winters of 1952 - 1953 and 1955 - 1956, for they are generally more representative of other winters. From Figure 1, it can be seen that the winter temperature variation curve in South China (whether it be for the maximum, minimum or mean temperatures) is practically made up of many groups of fluctuations, and a steady level line is seldom ever seen. When compared with summer temperature conditions (Figure 2), there is a great difference. During the course of temperature variations as shown in Figure 1, the temperature drop is seen to be extremely sharp and abrupt in some instances.

Classification of Temperature Drop Standards and Comparison of Temperature Drops in South China with That of Other Regions

While it is generally recognized that cold waves and cold air masses enter China from Siberia, the resulting temperature drop should be most drastic in North China and Northwest China, which are the first in their direct paths, after which come the temperature drop for Central China, and that for South China should show the least change. However, facts do not prove this to be so [Note 1]. We have compared the winter temperature drop conditions for the different regions of South China (selecting that for Nanning and Canton as examples), Central China (Nanking, Hankow), the Szechwan Basin (I-pin), [Note 2] and Northwest and North China (Cheng-chou, Peiping) in Table 1. Designations of

"small, medium, large, extra large" represent the classification of temperature drop standards in four grades as described in a previously mentioned classification [Note 3].

([Note 1] Should observations be made solely from recorded minimum temperatures, then due to latitude differences of North China, Northwest China, Central China and South China, and the gradually moderated cold waves and cold air masses that descend south from the north, it is only natural for the minimum temperatures of Northwest China and North China to be lower than for Central China, and the minimum temperature for Central China to be lower than that for South China. Quite obviously, comparison along these lines is illogical.)

([Note 2] In the Tentative Schemes for Dividing the Natural Regions of China, the Szechwan Basin is included in the Central China region. However, the winter climate of Szechwan (especially that in the valley section in southern Szechwan) is characteristically different from that of the Central China region, so it is listed separately.)

([Note 3] Daily temperature minimums are used here. However, in classifying the small temperature drop (when the range variation of temperature drop is between 7.5° and $10.0^{\circ}C$), any occurrence with a minimum temperature drop only a little less than $7.5^{\circ}C$ and a mean daily drop variation greater than $10^{\circ}C$ should be grouped with the classification for small temperature drops (this seldom occurs - about 3 times in 120). Whether this is included in compilation of statistics or not does not make much difference. Furthermore, the temperature drop of the extra leap year month is compiled with the month that shows the lowest daily temperature minimum.)

The following observations are made from Table 1:

(1) Looking at it from the standpoint of the whole winter season, the temperature drop in South China is obviously much greater than in Central China, Szechwan, North China and Northwest China. According to records of readings from 1950 to 1957, the average occurrence of extra large, large, medium, and small temperature drops each winter in Canton is represented by 0.1, 1.0, 1.8 and 2.6 times, while the corresponding representation for Nanning is 0.3, 0.3, 3.2, and 3.5 times. For Nanking and Hankow in Central China, the corresponding representation is 0.3, 0.3, 2.7, 3.8 times, and 0.3, 0.1, 2.0, 3.0 times, respectively. For Peiping in North China, and Cheng-chou in Northwest China, the corresponding representation is 0.0, 2.5, 3.3 times, and 0.0, 2.6, 2.1 times, respectively. The more dangerous of these occurrences are the extra large and large temperature drops which occur on the average of once a year in the two South China locations (Nanning and Canton), while in the two Central China locations (Nanking, Hankow), the average yearly

occurrence is only 0.5 times, and in Northwest China (Cheng-chou) and North China (Peiping), this occurrence hardly appears at all. (Notes From 26 November 1952 to 2 December 1952, the temperature minimum in Peking dropped from 25°C to -13°C, a total drop of 15.5°C, which might be considered as a large temperature drop. However, the maximum and mean temperatures for 26 - 27 November went up, which showed that the temperature curve was not tapering off to a drop. Therefore, the temperature drop could only be figured from 27 November when the temperature minimum for that day was 0.3°C, until 2 December when it went down to -13°C. There was a total drop of 13.3°C, which could be considered only a medium temperature drop.)

(2) Take South China for instance. The more damaging extra large and large temperature drops practically always appeared during the months of January and February. In this record of seven consecutive winters, such a large temperature drop appeared only in December (it appeared once in December 1952 in Canton, and once in December 1950 in Nanning). Of course, this does not mean that any temperature drop occurring in November or December cannot be damaging. For we all know that while the sudden temperature drops in early winter and their accompanying temperature minimums are not as severe as those occurring during mid-winter, plants do suffer from frost damage since they have not sufficiently hardened themselves to the cold.

(3) Protected by mountains such as the Chin Ling and Ta-pa Shan, the possibility of Szechwan Basin being invaded by cold air masses is reduced and the severity of such invasion on penetration is also lowered. In this record of seven consecutive winters, there was no instance of a large or extra large temperature drop. Small temperatures drops occurred only nine times and medium temperature drops only twice. The average occurrence each winter of a small temperature drop was 1.3 times, and of a medium temperature drop, 0.3 times.

Table 1

Average Occurrence Each Winter of Temperature Drops in Various Grades From 1950-1957

Place	Peiping				Cheng-chou				Nanking				Hankow			
Grade / Month	Small	Medium	Large	Extra Large	Small	Medium	Large	Extra Large	Small	Medium	Large	Extra Large	Small	Medium	Large	Extra Large
Nov.	1.1	1.0	0	0	0.7	0.6-	0	0	0.9	1.0	0	0	1.1	0.7	0	0
Dec.	0.9	1.4+	0	0	0.6-	0.6-	0	0	1.1	0.3	0.1+	0.1+	0.9	0.1	0.1+	0
Jan.	0.6	0.6	0	0	0.3	0.9	0	0	0.9	0.7	0.1+	0.1+	0.6	0.3	0	0.3-
Feb.	0.7	0.4+	0	0	0.6-	0.6	0	0	0.9	0.7	0	0	0.4	0.9	0	0
Winter	n_1	n_2	n_3	n_4	n_1	n_2	n_3	n_4	n_1	n_2	n_3	n_4	n_1	n_2	n_3	n_4
(Nov.-Feb.)	3.3	2.5	0	0	2.1	2.6	0	0	3.8	2.7	0.3	0.3	3.0	2.0	0.1	0.3
Total (n)		5.8				4.7					7.1			5.4		

(Table continued on page 7)

(Table continued from page 6)

Place	I-pin				Canton				Nanning			
Grade / Month	Small	Medium	Large	Extra Large	Small	Medium	Large	Extra Large	Small	Medium	Large	Extra Large
Nov.	0.6	0	0	0	0.4	0.6-	0	0	1.1	0.3-	0	0
Dec.	0.1	0.1+	0	0	0.9	0.4	0.1+	0	1.3	0.6-	0.1+	0
Jan.	0.3	0.1+	0	0	0.7	0.3	0.7	0	0.4	1.3	0.1+	0.1+
Feb.	0.3	0	0	0	0.6	0.6-	0.1+	0.1+	0.7	0.1	0	0.1+
Winter	n_1	n_2	n_3	n_4	n_1	n_2	n_3	n_4	n_1	n_2	n_3	n_4
(Nov.-Feb.)	1.3	0.3	0	0	2.6	1.8	1.0	0.1	3.5	3.2	0.3	0.3
Total (n)		1.6				5.5				7.3		

Types of Temperature Drops and an Evaluation of Protective Preventive Agricultural Measures

According to the surface circulation of the cold air masses and weather conditions (which are reflected on the daily variations of maximum and minimum temperatures), temperature drops may be classified chiefly into four types:

Type I

In the daily process of changes in the weather elements, this type may be divided into four smaller stages. First, there is a temperature drop (period) in the surface circulation which is expressed in the simultaneous drop in both the maximum and minimum temperatures, and cloudy skies that are often accompanied by light rain and strong winds. The second stage shows signs of stabilization (period) where changes in the maximum and minimum temperatures are very slight (a slight increase or a slight drop), the diurnal variations in temperature are very little, though the skies are still cloudy and the rain has ceased or still shows a trace with greatly diminished winds. The third stage is (the period) of drop in the radiation temperature when the skies become clear again, the winds have ceased altogether or weakened, and the maximum temperature begins to climb while the minimum temperature continues to drop so that the lowest temperature value and the greatest diurnal temperature variation of the whole temperature drop process are seen at this time. This stage generally lasts two or three days, though only one day sometimes. The last stage is a period of reversion to rising temperatures when the maximum and minimum temperatures both rise (oftentimes rapidly) and the cycle of a temperature drop is completed. Since the danger of low temperatures has now been removed, this stage actually should not be part of the temperatures drop cycle, but its description is included for clarification purposes. Temperature variations during the various stages of the temperature drop process are shown in Figure 3.

This type is the most typical of temperature drops occurring in South China and one seen most frequently during the winter. Beginning from the first stage to the end of the third stage, the duration of such a temperature drop generally lasts 5 to 10 days, though occasionally there may be a temperature drop lasting less than 5 days or lasting longer than 10 days. Not only are the abrupt temperature drop in the beginning and the accompanying strong winds harmful to the crops, the low temperature of the third stage (the period of radiation) which oftentimes go below $5^{o}C$, the great diurnal variations in temperature and the strong daytime insolation are all harmful to crops to a certain degree. The most effective protective measure is the portable frost shield. This is a screen of woven straw and bamboo which is placed against the wind on the windward side during the temperature drop stage of the surface circulation so that the crops are shielded and protected

from the cold winds. Cutting down the wind velocity greatly increases the cold resistance of plants. However, during the second stage when the wind velocity is reduced, the straw screen may be placed on top of the plants (naturally, a supporting framework of wood and bamboo built a little higher than the plants must first be erected for the straw screen to be placed above the plants). This way, the radiation temperature drop may be slowed down. According to the results of observation by certain experimental units (such as the Institute of Subtropical Plants, the Kwangsi Experimental Station, the Fukien Provincial Department of Agriculture) in the provinces of Kwangsi and Kwangtung during the last three years, the temperature below the straw screen is oftentimes 2^{o} - $3^{o}C$ or more higher than those outside the screen at the same height. Therefore, frost damage from low temperature is greatly reduced. Furthermore, before the temperature starts climbing again, it is not feasible to remove the screen because plants that have not recuperated from the shock of the low temperature will be further damaged when exposed to the strong rays of the sun. Based on research on plant physiology, the cells of seedling plants do not always die when first attacked by cold, and there are times when a definite ability toward revival is noticed. However, should it be subject to the strong rays of the sun immediately, the damaging effects will be increased and revival will be impossible. From this it can be seen that the functions of the portable frost screen are three: (1) serving as a wind break, the plants are placed in a situation with a higher cold resistance; (2) during the period of temperature drop in the radiation, it keeps the minimum temperature below it higher than that outside by 2^{o} - $3^{o}C$ or more; and (3) acting as a sunshade after a temperature drop in the radiation, it allows the cold exposed plants a better chance for revival.

Type II

The characteristic of this type of temperature drop is seen in the rapid simultaneous drop of the maximum and minimum temperatures which is followed by a simultaneous rapid temperature rise of the two. This is to say that in this type of temperature drop, there is a period of temperature drop in the surface circulation and a period of reversal to rising temperatures, with or without a temporary (only of one day duration) and unnoticeable period of stabilization or period of drop in the radiation temperature. This type of temperature drop occurs less frequently than Type I, but is seen quite often. A somewhat typical example is seen in the temperature drop that took place in Canton on 9-16 January 1951. The sustained interval of this type of temperature drop is the shortest of all types, but its resultant drop in temperature volume and minimum temperature value are sometimes outstanding. Take the example of Figure 4 for instance. The minimum temperature in Canton on 9 January 1951 was $16.4^{o}C$, but in a period of 14 days it had dropped to $0.6^{o}C$. On 14 February 1952, the minimum temperature in Canton was $21.4^{o}C$, and in a period of 19 days, the

temperature dropped to 1.6°C, a drop of 19.8°C altogether. A temperature drop of maximum temperatures was even more frightening when the temperature on the 14th dropped from 28.2°C to 5.2°C on the 18th, adding up to a total drop of 23.0°C within 4 consecutive days. This is to say that within a period of 4 days, the temperature changed from that of hot summer to cold winter to cause severe frost damage to plants. However, due to its "abrupt arrival and departure," the adoption of preventive measures such as windbreaks, frost screens, straw mulch, and hilling up with dirt will show obviously better results with this type of temperature drop than with any other type.

Type III

This type of temperature drop includes two or even three periods of temperature drop in the surface circulation with periods of stabilization, radiation, or rising temperatures spaced in between, and finished off with a period of drop in the radiation temperature. Its temperature variations are shown by Figure 5.

The example illustrated in Figure 5 is the well known cold wave that occurred in January 1955 when a heavy frost appeared throughout South China and the northern part of Hainan Island, accompanied by freezing of still bodies of water. Such cold had never been experienced before by many old peasants, and the damage to crops, especially the tropical types, was quite great. The course of this temperature drop was of the complex type which included three stages of obvious drop in the surface circulation (which were spaced by periods of stabilization or temperature rise) that resulted in low temperatures never met before in several decades of weather recording in South China. Expression of the course of this temperature drop on the weather charts is shown as the result of a continual invasion of South China by the cold air mass of a strong high pressure cold front in intermittent waves. This type of temperature drop, especially with its inclusion of three drops in the surface circulation, is seen very infrequently. Characteristics of this temperature drop are especially low temperatures of long duration and a great diurnal variation in temperatures. All these factors are unfavorable to crops. However, based on surveys by us and some other researchers, plants grown in a favorable environment (governed by such factors as topography, etc.) and accorded protective measures beforehand are shown definitely to suffer less damage than plants grown in an unfavorable environment without the benefit of any protective measures.

Type IV

The chief characteristic of this type is the appearance of a long period of cloudy (rainy) weather after a temperature drop in the surface circulation. Take the temperature drop in surface circulation that began on 3 February 1957, for instance. The cloudy (rainy) weather

continued to the end of February. The diurnal variations in temperature were usually below 5°C or 3°C; for half a month minimum temperatures were below 10°C while for ten days the mean temperature was below 10°C. Due to the long duration of cloudy (rainy) and cold weather, certain plants such as the banana tree and other fruit trees suffered serious damage. The temperature variations of this type of temperature drop are shown in Figure 6. Due to the longer duration of this type of temperature drop, its harmful effects on agricultural plants are not known until later. Furthermore, the reaction of different types of plants varies. Take the cold spell that occurred in February 1957. After it had passed, great damage was found done to the banana trees, and there was some damage to the Nephelium litchi and papayas and very slight damage to the Nephelium longana. This situation is different from the one during the heavy cold damage of January 1955, when the damage suffered by various tropical fruit trees and certain warm loving field crops was quite heavy, but damage suffered by the banana trees then was not as great as that occurring in February 1957. There is a definite value in the protection afforded by windbreaks and frost screens against this type of temperature drop. As for other measures such as dirt hilling and straw mulching, their effectiveness was not obvious because the duration of cloudiness (rain) and cold was too long. Luckily, this type is seen very infrequently in South China, and according to what we know, it happened only once.

The General Characteristics of Temperature Drop in Winter in Southern China (English abstract)

The winter climate of South China is usually mild, but occasionally when the cold waves break out from Siberia or elsewhere and push southward, the temperature may drop 10, 15, or even 20°C within a few days, therefore damages caused by the sudden drop of temperature on tropical plants were incurred frequently.

Comparisons of changes of temperature of Northwest, North and Central China, indicate that the drop of temperature in South China is the most striking one during the invasion of cold waves. Here the author proposes the use of complex index number for the temperature variations, so the special characteristics of the temperature range and the interdiurnal temperature variation may be revealed. A discussion is also given for the low temperature damages to agricultural plants.

In this paper much attention was placed on the distribution of such low temperatures as influenced by different topographical features during the cold spells, and suggestion was made as to how to select shelters for tropical agricultural plants.

Four kinds of temperature dropping types effecting agricultural plants were mentioned. And measures to be taken for protection of plants against low temperature damages were suggested.

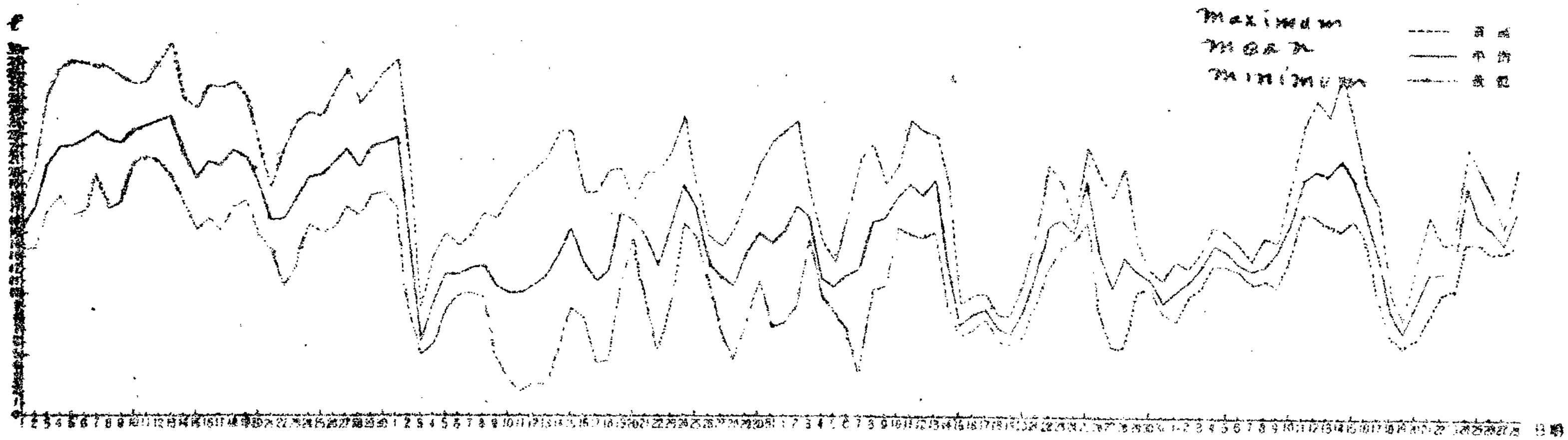

Figure 1. (a) Daily Temperature Variations in Nanning from November 1952 - February 1953 (winter)

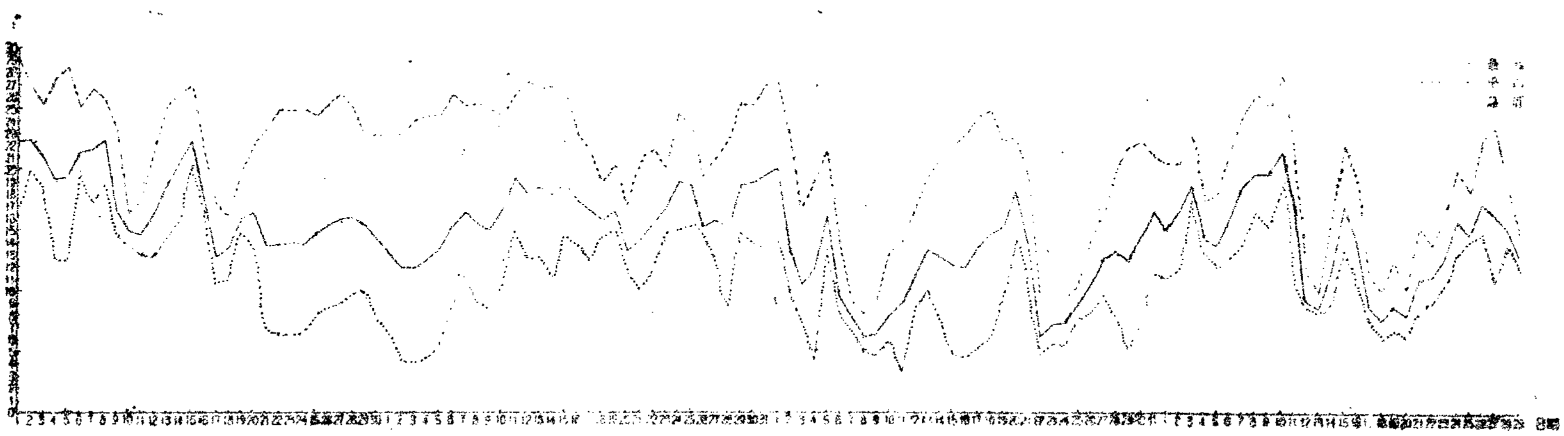

Figure 1. (b) Daily Temperature Variations in Nanning from November 1955 - February 1956 (winter)

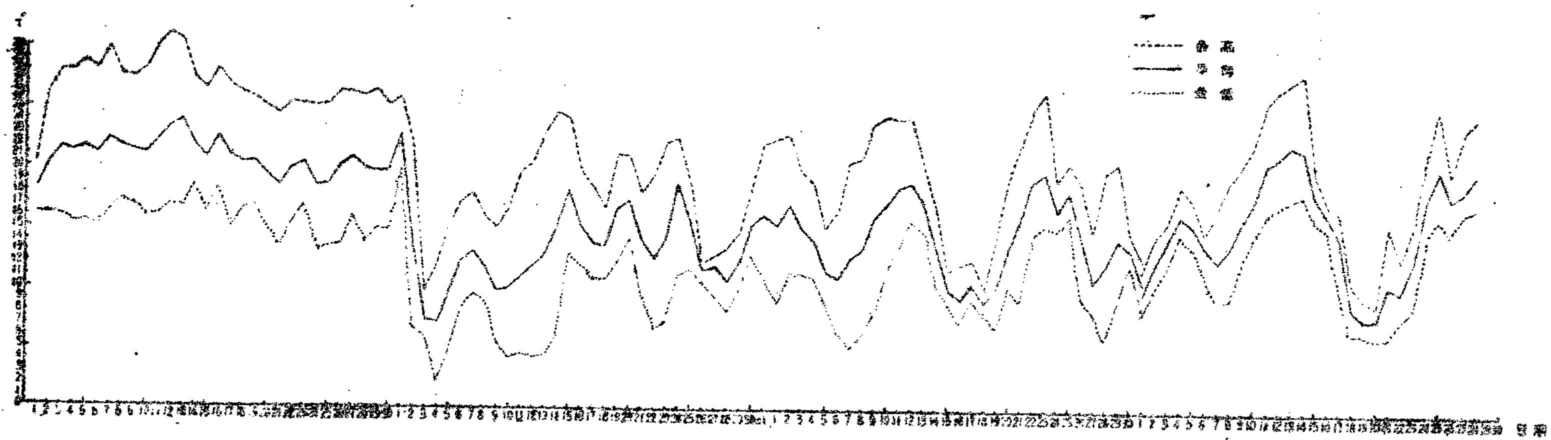

Figure 1 (c) Temperature Variations in Canton from November 1952 - February 1953 (winter)

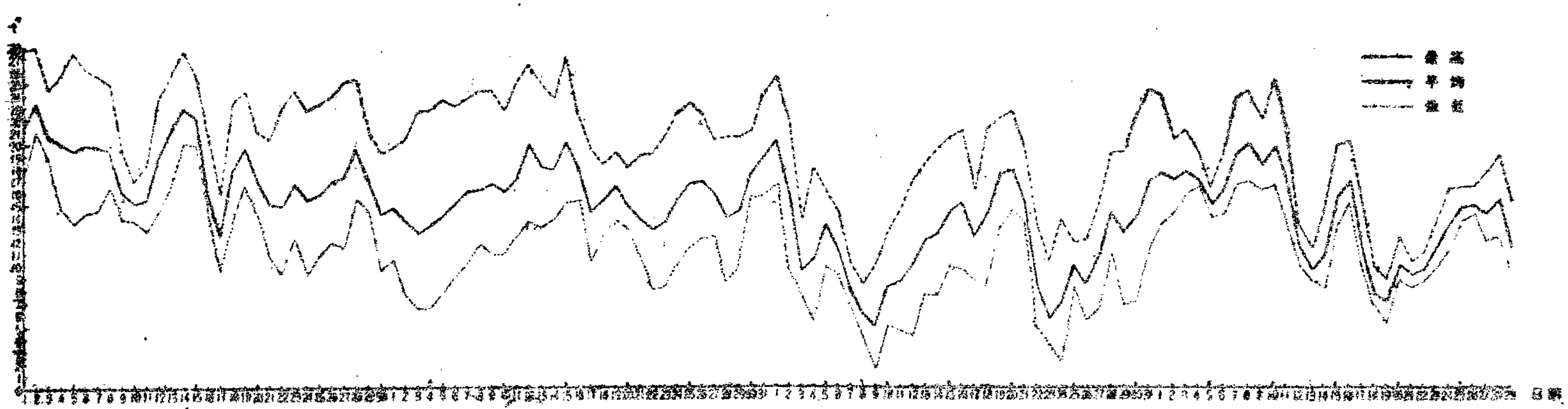

Figure 1 (d) Temperature Variations in Canton from November 1955 - February 1956 (winter)

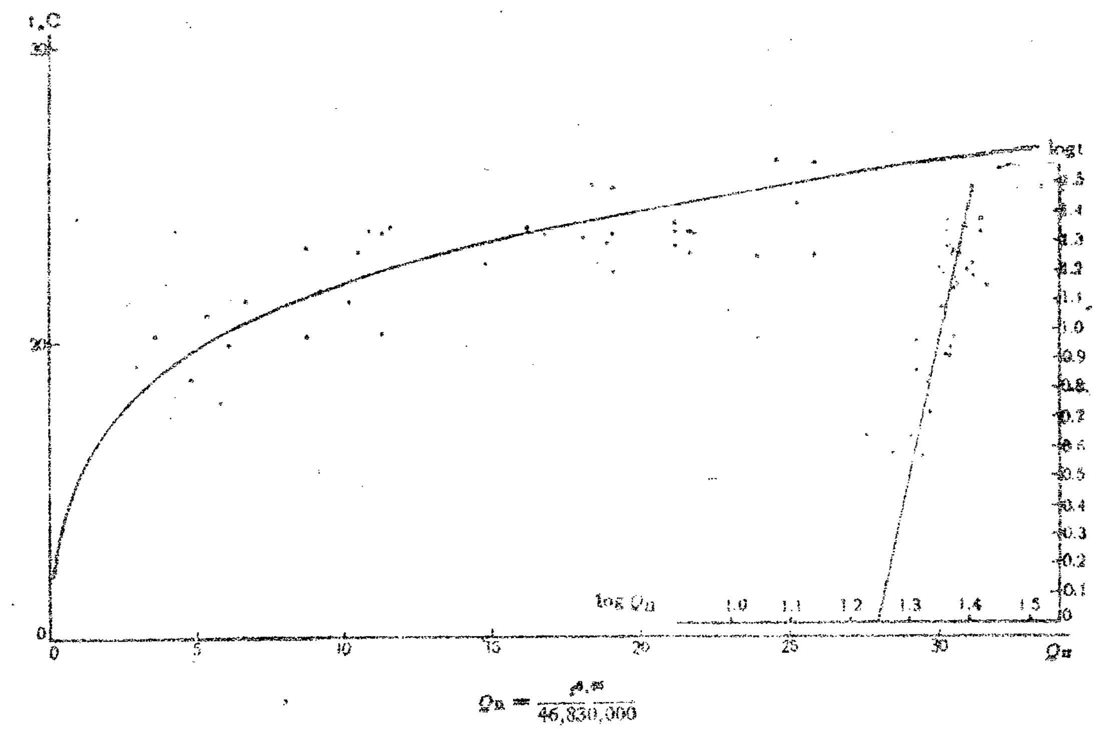

Figure 2 Daily Temperature Variations in Canton from June - September (summer) 1955

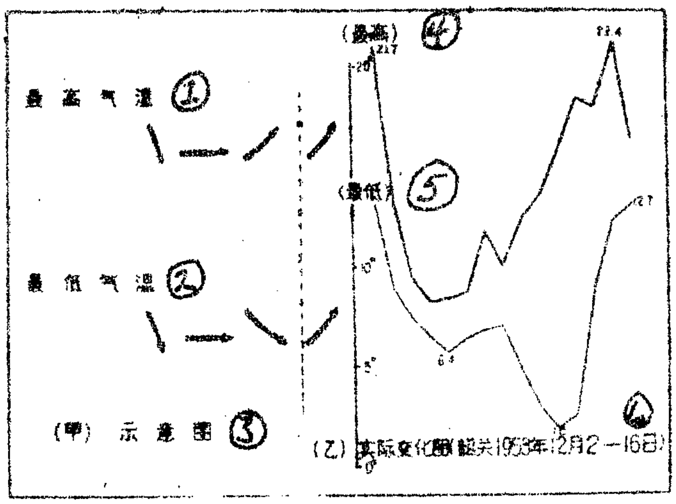

Figure 3. Temperature Variations of Type I

Legend:
1. Maximum temperature
2. Minimum temperature
3. (A) Descriptive figure
4. Maximum
5. Minimum
6. (B) Actual Variations (Shao-kuan, 2-16 February 1953)

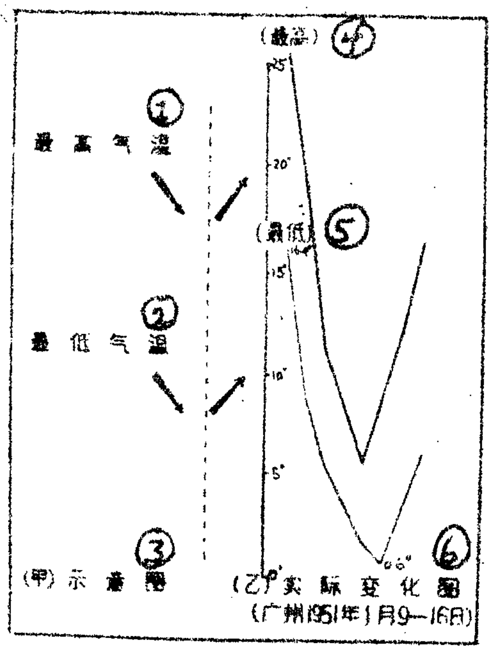

Figure 4 Temperature Variations of Type II

Legend: 1. Maximum temperature
2. Minimum temperature
3. (A) Descriptive figure
4. Maximun
5. Minimum
6. (B) Actual variations
(Canton, 9-16 January 1951)

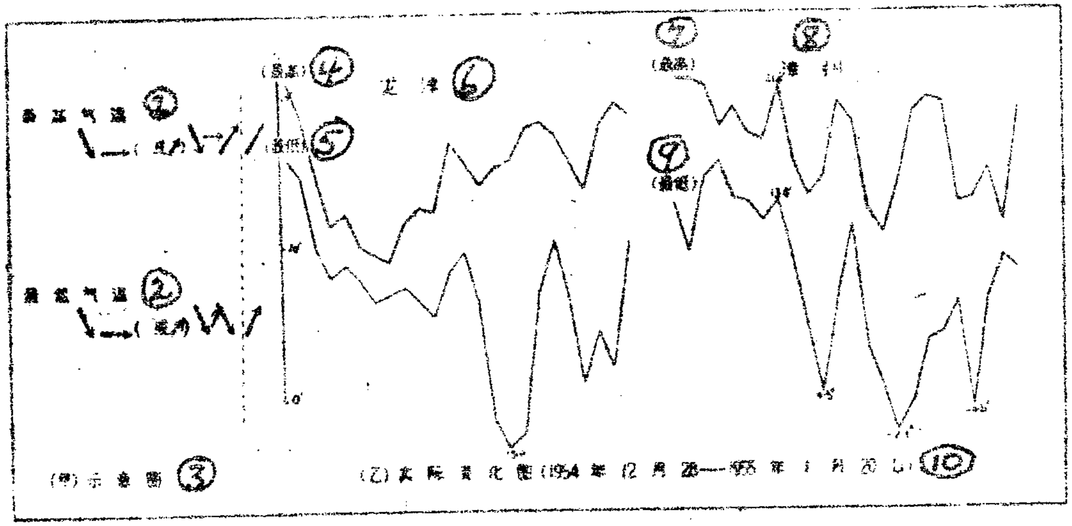

Figure 5 Temperature Variations of Type III

Legend:
1. Maximum temperature (or)
2. Minimum temperature (or)
3. (A) Descriptive figure
4. Maximum 5. Minimum
6. Lung-ching
7. Maximum 8. Minimum
9. Chang-chou
10. (B) Actual Variations Chart (28 December 1954 - 20 January 1955)

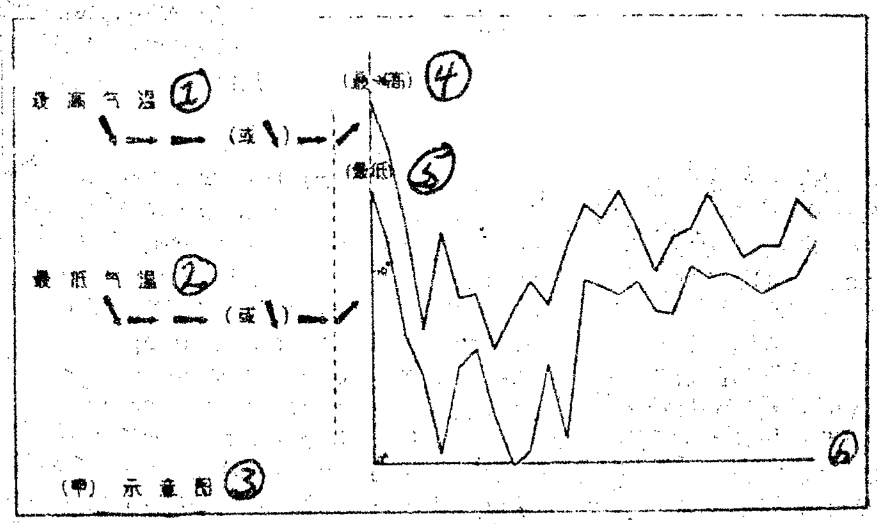

Figure 6 Temperature Variations of Type IV

Legend: 1. Maximum temperature (or)
2. Minimum temperature (or)
3. Descriptive figure
4. Maximum 5. Minimum
6. Actual Variations Chart
(3-28 February 1957 at Canton)

III. PRELIMINARY ANALYSIS OF HYDROGRAPHIC CHARACTERISTICS OF INTERIOR DRAINAGE RIVERS IN KANSU

Pages 67 - 89, (excerpts)

Liu Ch'ang-ming, Institute of Geography, Chinese Academy of Sciences

Chang Yun-shu, Kansu Provicial Department of Water Improvements

General characteristics of the rivers show them to be short and rapid with a clear cut division and making frequent course changes in the river bed downstream -- at one location in the morning and another in the evening. All the river courses are divided between those in the mountain sections and those out of the mountain sections. The sections in the mountains see broad valleys and steep slopes. The vertical gradients of the rivers at their sources are generally 33%, with others varying between 10% and 33%. Horizontal cross sections show a gradual sloping. The composition matter of the river beds is made up of rocks and large pieces of gravel washed down from the mountain slopes. The courses of the rivers out of the mountains show a gentler vertical gradient generally between 1% and 10%. The horizontal cross sections show an open broadness, and rivers at this stage show much branching out. Take the Tsa-mu Ho for instance. After leaving the mountains, it branches out into seven parts which meander through the sandy gravel. Composition matter of the river beds now is mostly sandy gravel, and due to its great porousness, the rivers are oftentimes buried beneath the sandy gravel as hidden underground rivers. Valleys and canyons are found between river courses, whether in or out of the mountains, and hydrographic control stations for the various rivers are usually established at the valley or canyon entrances. Inside the valley canyons, the vertical slopes are found to be quite steep, with their gradient usually between 10 and 20%. The horizontal cross sections are most narrow here, making such locations the best sites for construction of reservoirs. Special characteristics of the various rivers are listed in detail in Table 1.

Table 1

River System	River	Length (km)	River Section in Mts. Longitudinal Slope (%)	River Section in Mts. River Bed Matter	River Section Outside Mts. (Corridor) Longitudinal Slope (%)	River Section Outside Mts. (Corridor) River Bed Matter
Ta-ch'ing Ho	Ta-ching Ho	50	25	Rocky matter	1.6 ~8	Pebble
Shih-yang Ho	Ku-lan Ho	137	-	Rocky matter	6.7	Pebble Tsa-mu spring
	Huang-yang Ho	105	13.3	Rocky matter	1.7	Pebble
	Tsa-mu Ho	130	13	Rock gravel	1.3	Pebble
	Chin-ta Ho	100	-	Rocky matter	-	Large pebble
	Hsi-ying Ho (Huai-an Ho)	124	12.5		4.5	Pebble
	Tung-ta Ho	133		Rock & large rocks		Pebble
Hsi-ta Ho	Hsi-ta Ho					Pebble gravel
Hei Ho	Hei Ho	800	33~10	Rock large gravel pieces	5~2	Small pebble gravel
	Shan-tan Ho			Rocky mat.		Gravel
	Li-yuan Ho			"		"
	Tu-lai Ho			"		"
	Hung-shui Ho	125		"		"
	Ma-ying Ho and Feng-tung Chuan			"		"
Pai-yang Ho	Pai-yang Ho			"		"
	Ch'ih-chin Ho	150	33	"	5.5	"
Su-le Ho	Chang-ma Ho	630	10	"	1.66~1	"
	Tang Ho		8.5	"		"
				Rock pieces	5~1.66	"
	T'a-shih Ho			Rocky material		Gravel

When comparing rivers of this region with those of eastern China, rainfall is seen as an important source of supply for both, though the chief characteristic of rivers in this region is the great amounts of melted snow and ice that feed them. Due to the penetration of rain water and melted snow and ice into the ground, underground water that empties into the rivers also becomes a source of supply. Where rainfall and melted snow and ice are the chief sources of river water supply, such conditions are found to prevail mostly in the Chi-lien Mountain area, and where underground water as a source of water supply is only secondary, it is found mostly in the plains of the Kansu corridor. The various sources of supply are explained in the results of dividing the course of the Hung-shui Ho from its mid-section in the Chi-lien Mountains (Figure 1). Water feeding it belongs to the mixed ice, snow, and rain water type.

Rain water is an important source of river water because rainfall during the summer months makes up most of the annual precipitation volume and the area covered by summer rainfall in the mountains area is more extensive, so that rainfall as a source of water supply originates mostly in the great mountain areas. Rainfall in the plain of the Kansu corridor is quite scant and due to the easy penetration and evaporation of water in the desert, it is hard for rainfall to form torrential streams to supply the rivers. For this reason, it is basically impossible to consider rain water as a source of water supply to originate in any area of the corridor, especially the western part. The volume of rain water that supplies the various rivers is closely related to the distribution of rainfall. As has been described, the distribution of rainfall shows an increase from the west to the east, so that rain water as a source of water supply becomes gradually more important to the east.

The existence of snow and ice as a source of water supply is an important characteristic of the rivers in this region. Alpine distribution of snow and ice is concentrated chiefly in the midsection and western section of the Chi-lien Mountains at such places as Hung-shui Liang, To-lai Shan, South To-lai Shan, South Su-le Shan, Yeh-ma Shan, South Tang Ho Shang, etc, and at the eastern tip of the Chi-lien Mountains at Leng-lung Ling located upstream of the Shih-yang Ho river system. According to statistics from material provided by the Chinese Academy's Research and Survey Unit on the utilization of alpine snow and ice, present day glaciers belonging to the various watersheds of this region cover an area of about 1,300 square kilometers, with a water storage volume of more than 40 billion steres. The vertical distribution of alpine snow and ice is found on uplands more than 4,200 meters above sea level in general, and due to the influences of topography, the distribution is not continuous.

In the zone of torrential stream formation, the distribution characteristic of torrential stream volume shows a heavier concentration in the southeast and a lighter one in the northwest, much like the pattern of precipitation distribution. At the eastern tip of the Chi-lien Mountains, the various upstream tributaries of the Shih-yang Ho, and Hsi-ch'a and Huan-leng-lung Ling located upstream of the Hei Ho, make up the largest center of torrential streams in the whole region. This also coincides with the region's precipitation center showing more than 500 millimeters' precipitation. Within the limits of the torrential streams center, the torrential stream depth is above 300 millimeters, and in some individual streams (Hsi-ying Ho), the depth may exceed 400 millimeters (Figure 2). Toward the west of this center, the torrential stream depth decreases gradually until at the western part of the Su-le Ho watershed, the depth has dropped below 50 millimeters. The zero line of torrential stream depth generally follows the foothills at a contour-line of 2,000 meters, and extends westward where the contour-line gradually increases above 2,000 meters. The equal value lines of torrential streams within the zero line extend from the center outward encircling the mountains in an elliptical pattern. Grouped according to rivers, the torrential stream depth of the Shih-yang Ho river system is mostly between 100 and 300 millimeters; the Hei Ho river system is mostly between 100 and 200 millimeters; and the Su-le Ho river system is at 50 millimeters, but mostly below 50 millimeters. The torrential stream volume of the individual rivers are listed in Table 2.

Table 2

Statistics on Surface Water Resources in the Ho-hsi Area [Area West of the Yellow River] in Kansu

River System	Watershed	Control Point	Watershed Size (Square Kilometers)	Mean Annual Flowage Volume steres/sec.	Annual Torrential Stream Volume (100 million steres)	Annual Torrential Stream Depth (millimeters)	Time Limit on Resources (years)	Extended Time Limit (yrs.)
Shih-yang Ho	Ta-ching Ho	mountain exit	395	0.727	0.229	58		
	Ku-lan Ho	Ku-lan	1,318	2.42	0.764	58	1	10
	Liu-tiao Ho	mt. exit		0.508	0.160			
	Huang-yang Ho	water gap hydrographic station	785	5.527	1.742	222	9	10
	Tsa-mu Ho	Tsa-mu-szu hydro. sta.	875	9.69	3.055	366	5	10
	Chin-ta Ho	mt. exit	700	4.76	1.50	214		
	Hsi-ying Ho	Szu-kou-tsui hydro. sta.	1,163	16.42	5.18	448	3	10
	Tung-ta Ho	Sha-kou-szu hydro. sta.	1,175	13.54	4.24	360	3	10
	Hsi-ta Ho	Ch'a-chien-mun hydro. station	1,162	7.70	2.43	208	1	10
	All mountain gully streams	mt. exits	3,507	28.60	11.52	255		
	Total		11,080	89.802	28.31	255		

(Table continued on page 27)

(Table continued from page 26)

River System	Watershed	Control Point	Watershed Size (Square Kilometers)	Mean Annual Flowage Volume steres/sec.	Annual Torrential Stream Volume (100 million steres)	Annual Torrential Stream Depth (millimeters)	Time Limit on Resources (years)	Extended Time Limit (yrs.)
	Shan-tan Ho	mt. exit	900	2.73	0.860	97		
	Min-le Hung-shui Ho	mt. exit	400	4.70	1.48			
	Tung-tzu-pa	mt. exit		3.745	1.18			
Hei Ho	Hai-chao-pa;	mt. exit		6.10	1.92			
	Great and Little Tu-ma							
	Ma-t'i-szu Ho	mt. exit		0.191	0.06			
	Mt. gully streams near Min-le Hei	mt. exits		5.59	1.76			
	Ho mainstream	Ying-lo-hsia hydro. sta.	10,200	51.15	16.13	158	14	23
	Su-yu-kou Ho	mt. exit		2.604	0.82			
	Hsiao-yeh-kou Ho	mt. exit		0.699	0.22			
	Ta-yeh-kou Ho	mt. exit		0.222	0.07			
	Li-yuan Ho	Li-yuan-pao hydro. sta.	2,040	8.135	2.562	126	7	23
	Other mt. gully streams	mt. exits	750	2.99	0.942	126		
	Hung-ta Ho	mt. exit	242	0.603	0.19			
	Pai-lan Ho	mt. exit	487	1.905	0.60			
	Streams between Pai-lan & Ma-ying Ho	mt. exits	175	1.982	0.625			
	Ma-ying Ho	mt. exit	717	2.421	0.78			
	Feng-le Ho	mt. exit	642	3.52	1.11			

(Table continued on page 28)

(Table continued from page 27)

River System	Watershed	Control Point	Watershed Size (Square Kilo-meters)	Mean Annual Flow-age Volume steres/sec.	Annual Torrent-ial Stream Volume (100 mil-lion steres)	Annual Torrent-ial Stream Depth (milli-meters)	Time Limit on Re-sources (years)	Extended Time Limit (yrs.)
	Mt. gully streams between Feng-le and Ma-ying Ho	mt. exits	250	1.08	0.34			
Hei Ho cont'd	Mt. gully streams between Feng-le & Kuan-shan Ho	mt. exits	43	0.1905	0.06			
	Kuan-shan Ho	mt. exit	162.5	0.725	0.2285			
	Hung-shan Ho	mt. exit	246.3	1.049	0.331			
	Hung-shui Ho	Hsin-ti-pa Hydro. sta.	1,760.0	7.85	2.475		3	23
	Mt. gully streams between Kuan Shan & Hung-shui Ho	mt. exits	686.1	0.888	0.2794			
	Streams between Hung-shui and Tu-lai Ho	mt. exits	264.5	0.70	0.2508			
	Tu-lai Ho	Ping-kou hydro. sta.	6,687.7	23.34	7.34	110	10	23
	Ta-huang Shan	mt. exit	860.0	1.72	0.542	63.0		
	Total		29,773.1	136.8295	43.1657	145		

(Table continued on page 29)

(Table continued from page 28)

River System	Watershed	Control Point	Watershed Size (Square Kilometers)	Mean Annual Flowage Volume steres/sec.	Annual Torrential Stream Volume (100 million steres)	Annual Torrential Stream Depth (millimeters)	Time Limit on Resources (years)	Extended Time Limit (Yrs.)
	Pai-yang Ho	Tien-sheng-chiao hydro. sta.	959	1.61	0.505	52.6	1	23
	Ch'ih-chin Ho	Ch'ih-chin-pao hydro. sta.	1,580	1.27	0.385	25.3	1	10
Su-le Ho	Chang-ma Ho	Chang-ma-pao hydro-sta.	11,600	24.65	7.77	67.3	10	10
	T'a-shih Ho	Mo-ku-tai hydro. sta.	2,900	2.46	0.773	26.6	3	10
	Tang Ho	Sha-tsao-yuan hydro. Sta.	12,700	11.06	3.48	27.4	12	12
	Mt. gully streams of Su-le Ho	mt. exits	8,701	12.01	3.782	43.5		
	Total		38,440	53.06	16.805	43.5		
	Grand total		79,293.1	279.6915	88.2807	111.1		

The results of division into hydrographic areas are in Table 3 and Figure 3.

Table 3

Results of Division Into Hydrographic Areas

Large Name	Region Limits	Named Areas	Area Limits
Zone of Torrential Stream Formation	Chi-lien Mountains	a. Areas fed by rain and snow	Ku-lan Ho, Huang-yang Ho, Tsa-mu Ho, Chin-ta Ho, Hsi-ying Ho, Tung-ta Ho, Hsi-ta Ho, Shan-tan Ho, Min-le Hung-shui Ho, and upstream Hei Ho watersheds
		b. Areas fed by rain, ice, and snow	Watersheds of Li-yuan Ho, Pai-lan Ho,Ma-ying Ho, Chiu-chuan Hung-shui Ho, To-lai Ho, Ch'ih-chin Ho, Pai-yang Ho, Chang-ma Ho, etc.
		c. Areas fed by ice and snow	Tang Ho, T'a-shih Ho
Zone of Torren-tial Stream Disappear-ance	The Ho-hsi (west of Yellow R.) Corridor	a. Areas of underground rivers around the foothills	Zone surrounding the foothills of the Chi-lien Mountains
		b. Areas of stream dis-sipation into the oases	The corridor section east of Chia-ku-kuan
		c. Riverless desert areas	The corridor section west of Chia-ku-kuan

Preliminary Analysis of the Hydrographic Characteristics of the Ho-hsi Region of Kansu Province (Russian abstract)

The indefinite streams of Kansu Province originate entirely in the Nan-shan Range and descend into the Ho-hsi corridor. The former is the zone of formation of the flow and the latter the zone of disappearance due to the arid climate.

The rivers are fed mainly by precipitation and by the melting ice and snow along the Nan-shan Range. In the eastern part of the mountains the main source is rain water, and in the western part it is melted ice and snow. The basic rule of the distribution of the yearly flow is characterized by vertical and horizontal changes. In general, for an increase in elevation of 100 m, the depth (sloy) of yearly flow increases by 11 mm. With an increase in longitude of 10 minutes from west to east, the depth of yearly flow increases by about 13 mm. Long-term changes in the yearly flow have been measured. The coefficient of variation (C_v) is generally less than 0.3. The variation cycle for rivers in the east and west is not the same. The intra-yearly distribution of the flow varies. On all streams the flood waters occur in the warm season and the minimum flow in the winter. In the warm period (June-September) a part of the precipitation melts the ice and snow. The amount of run-off in this period usually comprises some 50-70% of the yearly flow. In the eastern part, because of the abundance of snow in the winter to spring period, there occurs a small spring maximum. Rain prevails in autumn and at the beginning of autumn, there often occurs a plentiful run-off.

The maximum run-off of streams comes predominantly in the three months of July, August and September. On streams in the eastern part, the maximum comes in September while on streams in the western part, it comes predominantly during July and August. The maximum mainly has showers as its source while melted ice and snow play a supplementary role. This is the formula for correlating the maximum run-off in multiples of 1% ($Qmax_{1\%}$) and the area of the basin (F):

$$Q_{max\ 1\%} = 6170F^{0.58}$$

The minimum run-off occurs in the winter and spring and is determined by the ice regime and supply regime.

Because the streams of the given area are fed mainly by the ice and snow and because the widely distributed mountain particles act as filters, the rivers are less muddy. The amount of erosion per unit of area generally comprises less than 200 tons/km^2 per year. The amount of erosion, as a rule, decreases by stages from east to west.

As to the formation and disappearance of flow, the given area has been divided into two main regions: the mountains of Nan-shan and the Ho-hsi corridor. The Nan-shan region has been further subdivided into subregions according to the supply and regime of the rivers: the area east of the Hei-ho belongs to the subregion of rain-snow supply; the area west of the Ch'ang-ma-ho to the subregion ice-snow supply, and between them lies the subregion of rain-ice-snow supply. The Ho-hsi corridor is subdivided into three subregions according to relief and hydrographic conditions: the Nan-shan piedmont belongs to the region of underground transmittal of the flow; the plain of the corridor lies within the limits of the Hsia-yu-kuan; east of them lies the subregion of the disappearance of the flow and to the west, the desert "flowless" subregion.

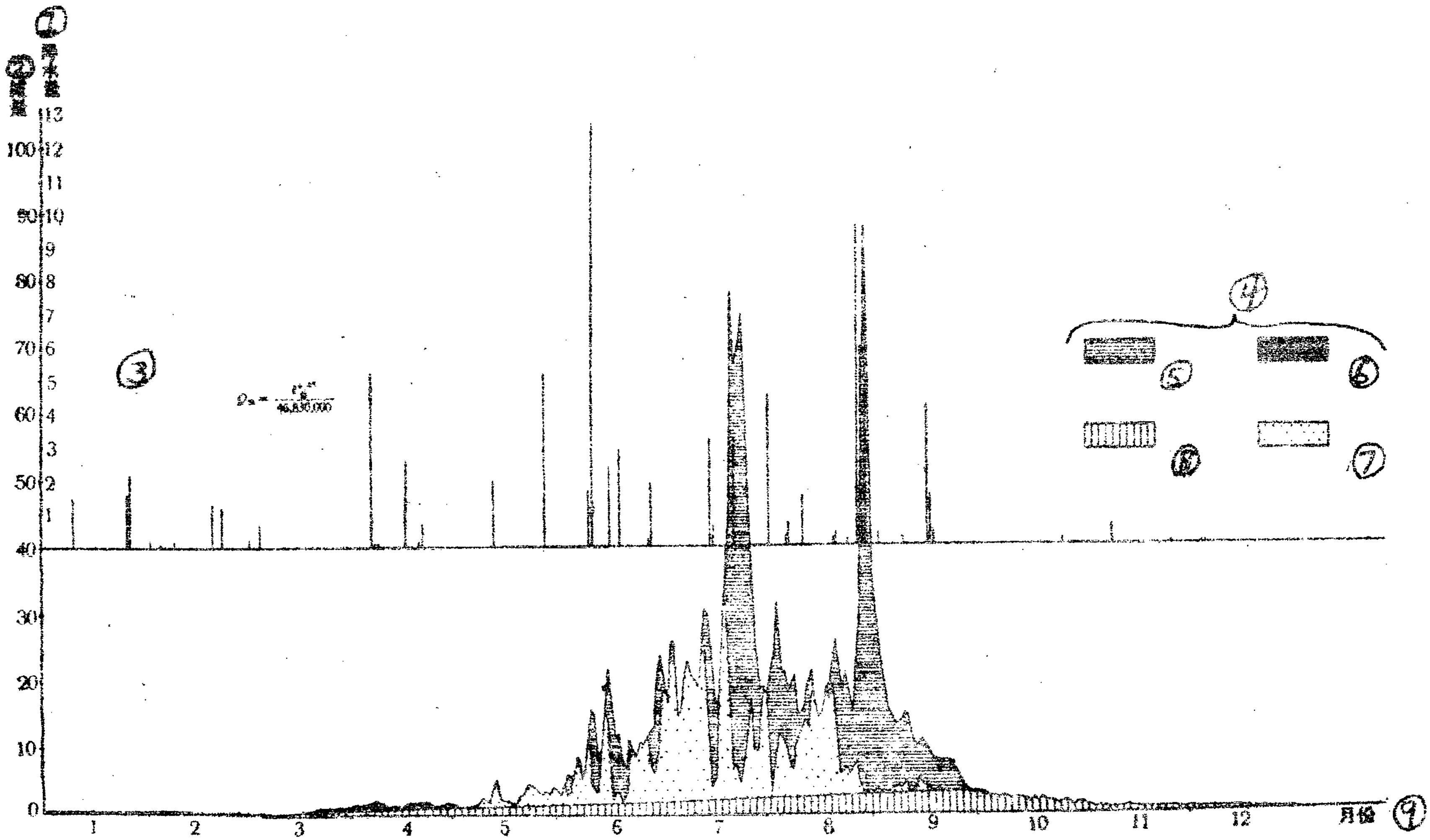

Figure 1 Analysis of Water Supply Sources for the Hung-shui Ho
Legend: 1. Precipitation, 2. Flow volume, 3. Supply by snow and ice based on: 4. Legend, 5. Supply from rainfall, 6. Supply from thawing ice, 7. Supply from melting snow and glaciers, 8. Supply from underground water, 9. Month.

5292 (Chinese)
5298 (Russian)

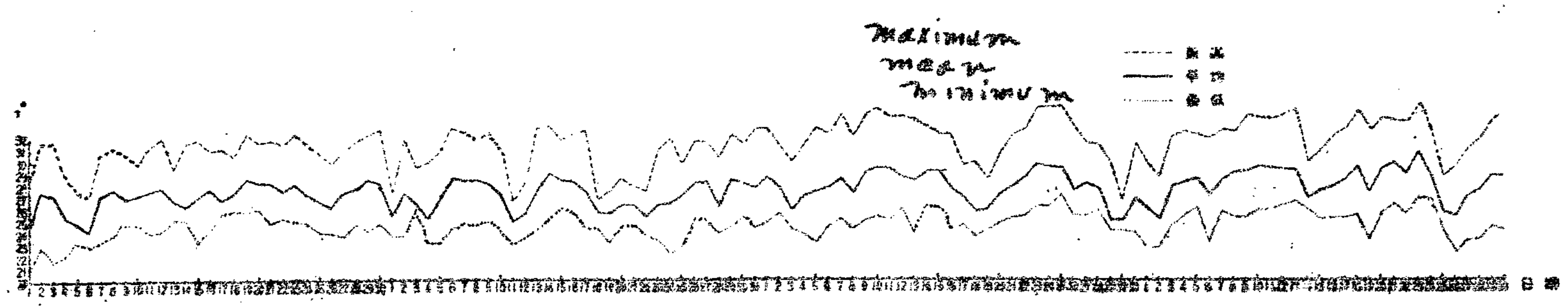

Figure 2 Equal Value Lines for Torrential Streams in the Interior Drainage River System of Kansu

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